

Optimization of the GOES-16/GOES-17 ABI L1b Calibration Algorithm for Re-processing Through a New Geostationary Imaging Support Team (GIST)

February 25-26, 2021

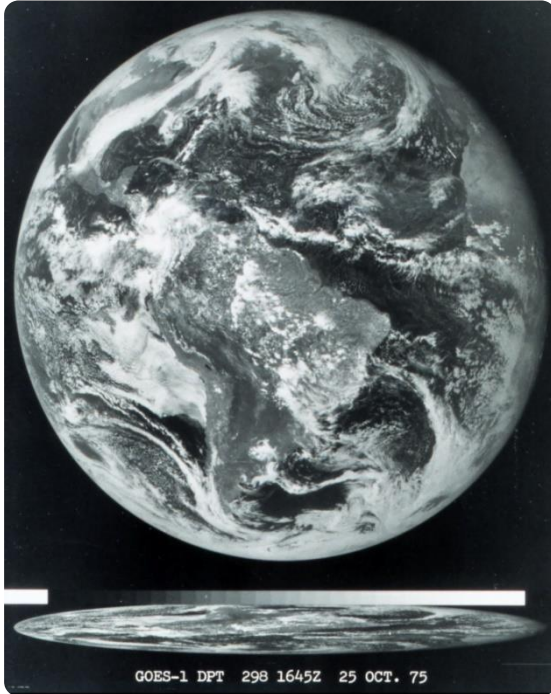
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Support: Boryana Efremova, Bin Tan, Aaron Pearlman, Francis Padula
Tiejun Chang, Emery Bacon

Geostationary Operational Environmental Satellite (GOES) Program

GOES-1

1st image October 25, 1975



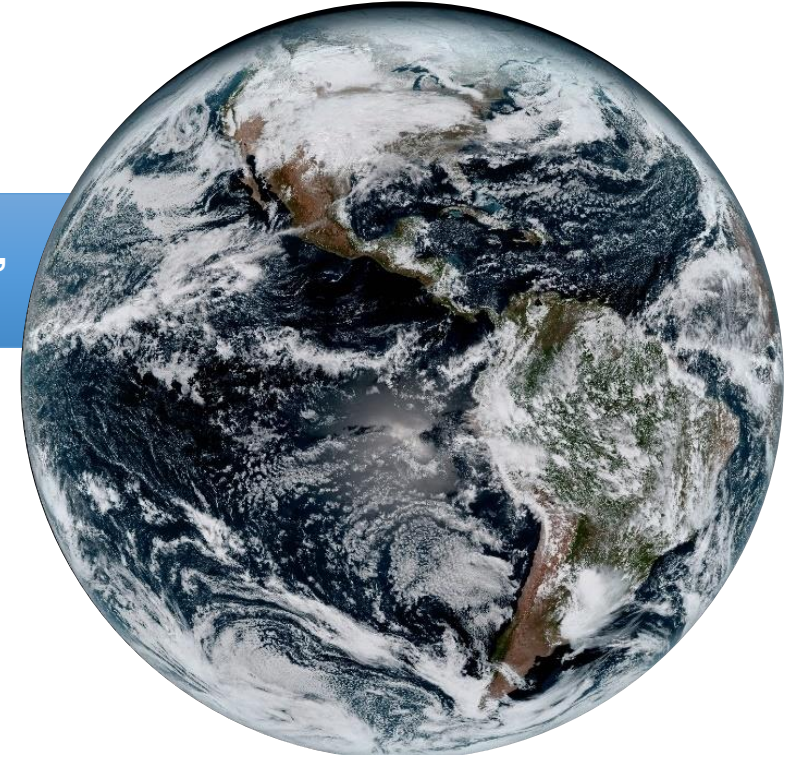
Real-Time Imaging of the Earth's Weather, Oceans,
& Environment

Enables new insights into the Earth system
with data more similar to MODIS & VIIRS

GOES-R Series

GOES-16

1st image January 15, 2017



Over 4 decades of Earth Observations

GOES-R Series

Two operational orbital position: GOES-East & GOES-West

GOES-R Advanced Baseline Imager (ABI)



Advanced Baseline Imager

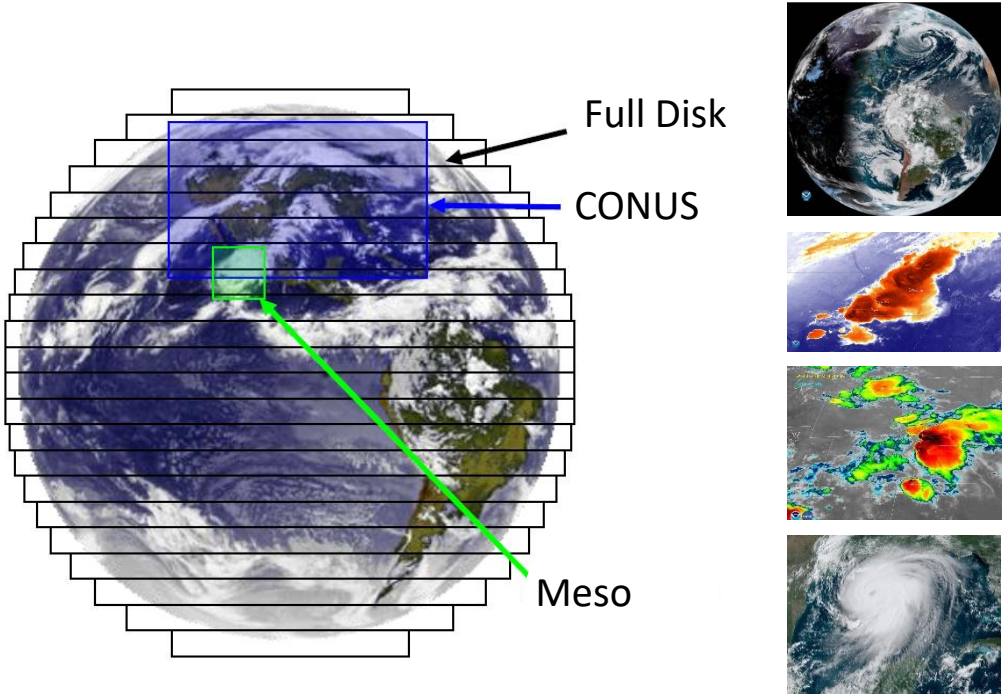
16 Band Imager



Rapid scan

ABI Scan Mode 6:

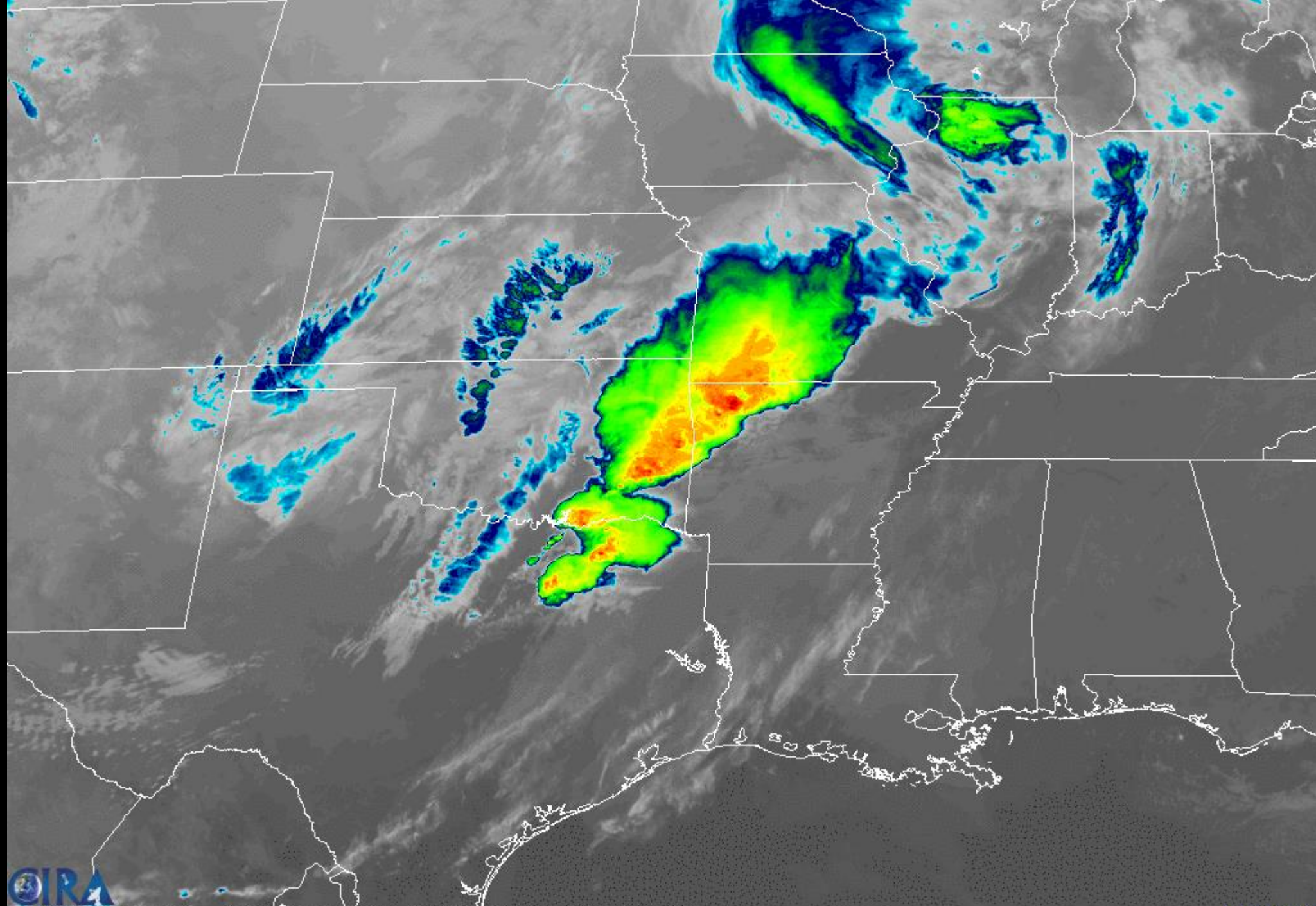
- 30-second Meso
- 5-minute CONUS
- 10-minute Full Disk



Spectral Region [μm]	Spatial Resolution [km]		
	0.5	1	2
VNIR/SWIR (6 bands)	0.64	0.47, 0.86, 1.61	1.37, 2.24
MWIR/LWIR (10 bands)			3.9, 6.2, 6.9, 7.3, 8.4, 9.6. 10.3, 11.2, 12.3, 13.3

On-Board Calibration Sources For All Bands

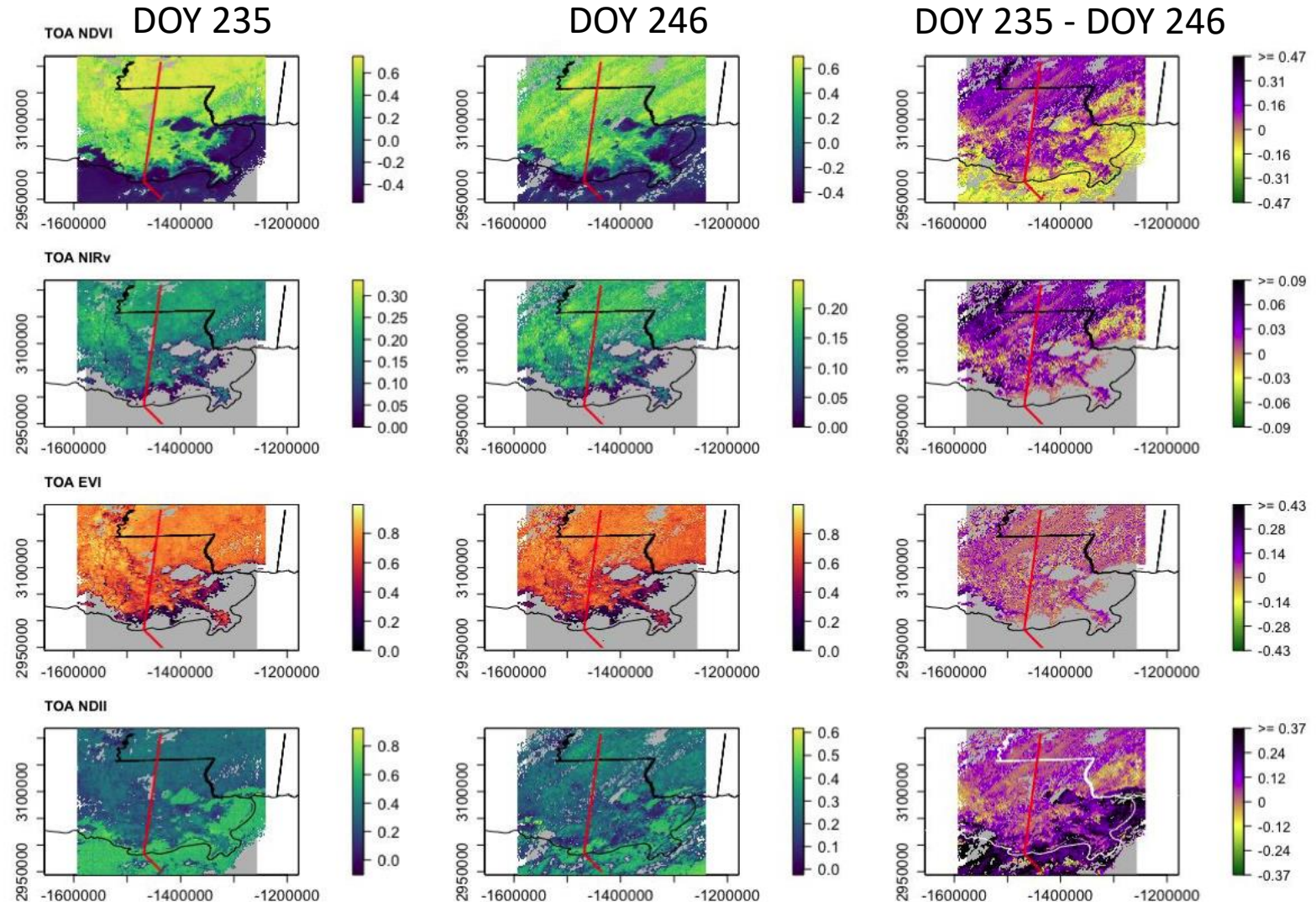
ABI Band 13
IR Imagery
Severe Weather
April 28-30, 2017



Geostationary imagers now have more horsepower for Earth science

Ongoing and emerging opportunities to improve environmental science using observations from Geostationary Operational Environmental Imagers

- Evapotranspiration, latent heat flux, and sensible heat flux
- Plant phenology
- Carbon cycle science
- Disturbance and recovery
- Ecosystem thermodynamics



The Need for ABI L1b Data Re-Processing

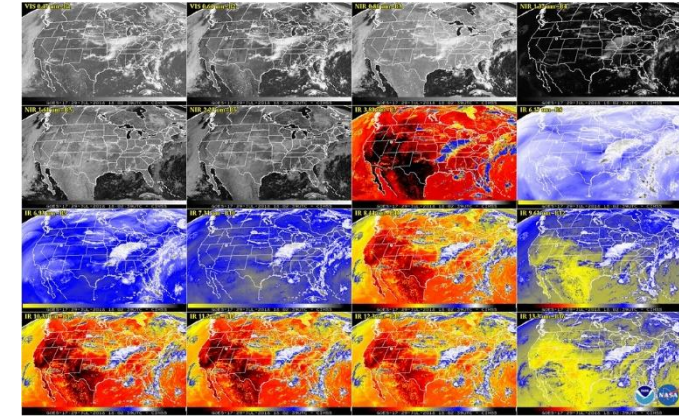
Operational GOES-R Series ABI:

- Real-time weather and environmental satellite observations
- Calibration is routinely updated to improve on its real-time data products

Consequently, ABI L1b long-term data records have numerous artifacts over time:

- Known radiometric and geometric calibration issues
- Other issues yet to be explored in the long-term trends

GOES-R Series

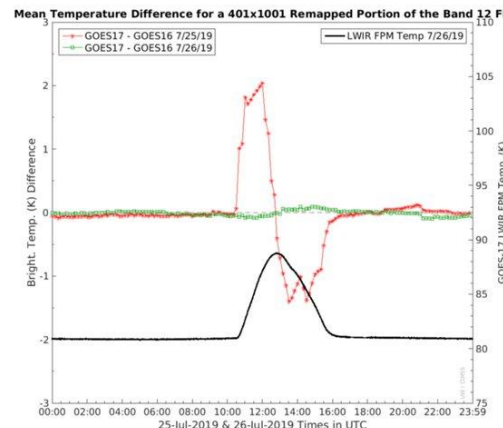


16 ABI L1b Imagery Bands

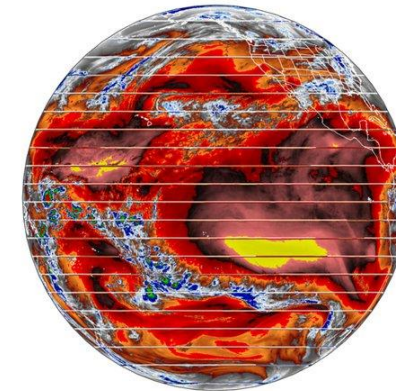
Address Radiometric & Geometric Calibration Issues:

- Ground processing discrepancies
- Anomalies discovered on-orbit
- Radiometric calibration artifacts
- Geometric image navigation and registration (INR) artifacts
- Other systematic artifacts in the data

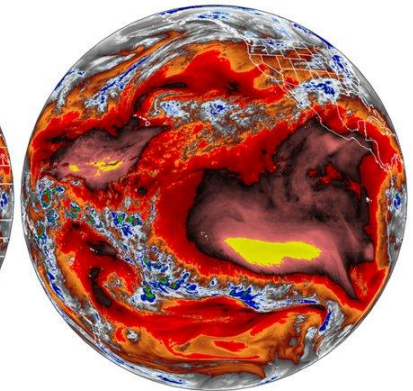
G17 During Thermal Anomaly



Baseline Cal.



Improved Cal.



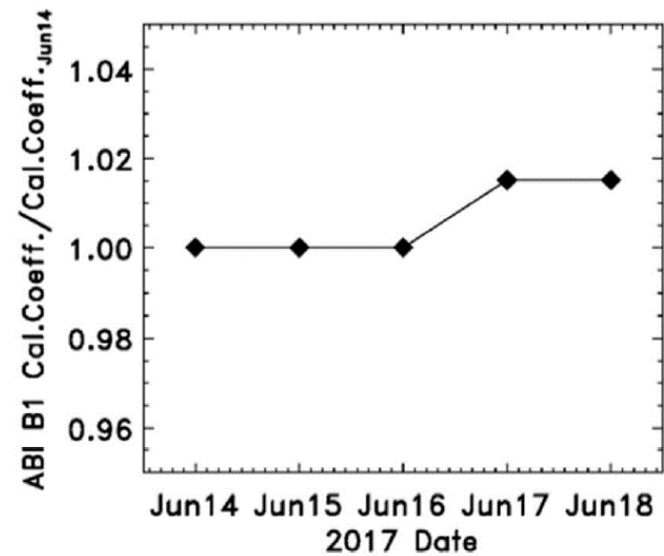
Additional Examples of Calibration Issues

Radiometric

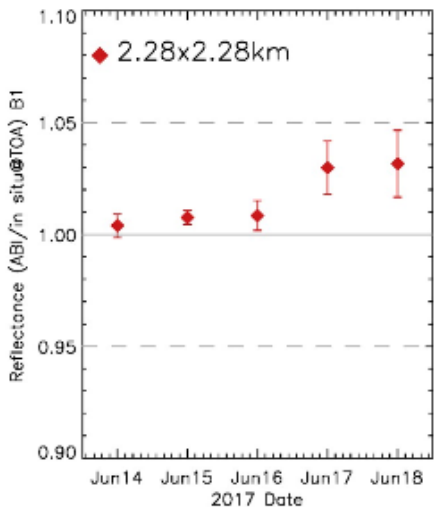
Example of instability of solar calibration coefficient during observed during GOES-16 field campaign (Salar de Uyuni, Bolivia)

- Observed a systematic 1% Jump in Ch. 1 ($0.47\ \mu\text{m}$)

Ch1 Gain Change



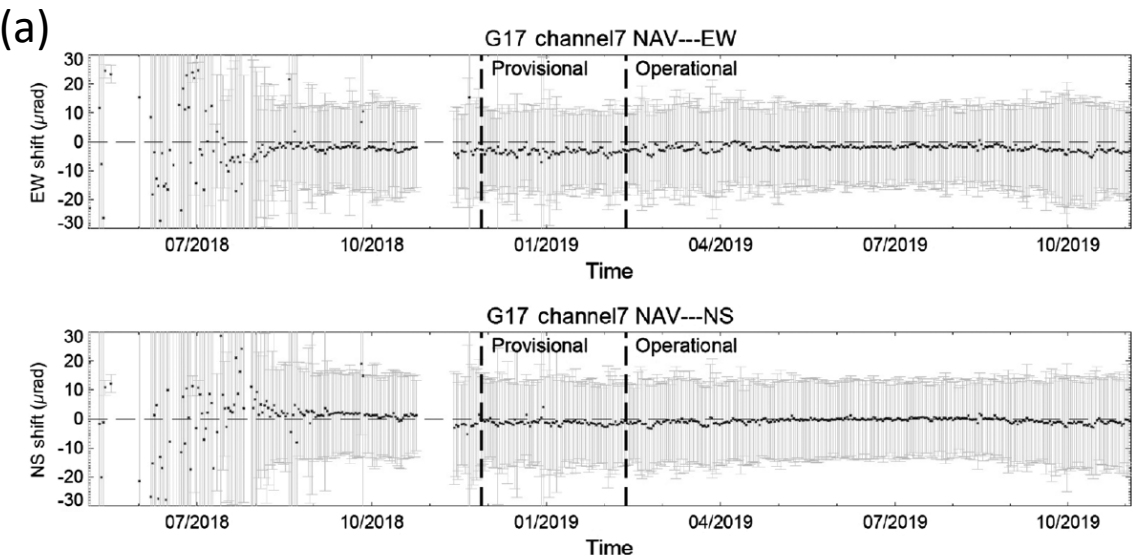
Field Campaign



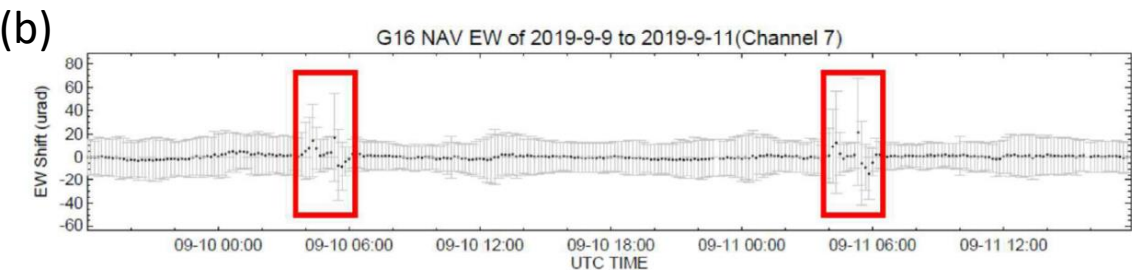
[McCorkel et al. 2020 Remote Sens. of Env.](#)

Geometric

- (a) Ex. of GOES-17 Ch 7 navigation accuracy & gradual drift over time
- (b) During the eclipse season, fast thermal deformations in the sensor around penumbral times lead to abnormal, large navigation errors for a short time period



[Tan et al. 2020 Appl. Remote Sens.](#)



GIST Project Overview



Objective

Re-process a subset of ABI data to demonstrate its potential for establishing a consistent long-term Earth science data record



Data

GOES-16 & GOES-17 ABI L1b data
January 01, 2019 to December 31, 2019
○ Special events such as field campaigns



Approach

Identify optimized radiometric & geometric calibration algorithms for re-processing of ABI L1b data



Data Processing

- Optimize offline ground processing code for re-processing to L1b (calibrated & navigated)
- Develop end-to-end reprocessing framework
- Identify future cloud processing architecture



Validation & Collaboration

- Validation studies to ensure initial results
- On-board sources, vicarious cal/val sites, & inter-comparisons with reference sensors
- Share data with NASA Earth science teams



Future

Provide an initial capability for the potential formation of a NASA Geostationary Imaging Support Team to ensure the Earth science quality of the ABI data record & potentially other Geostationary imagers.

NASA Earth Science Research on Operational Geostationary Satellite Systems (ESROGSS)

Radiometric Team

Geometric Team

Data Storage & Resources

GOES Data

Reprocessing ATBD

Native LUTs

Analysis Derived LUTs

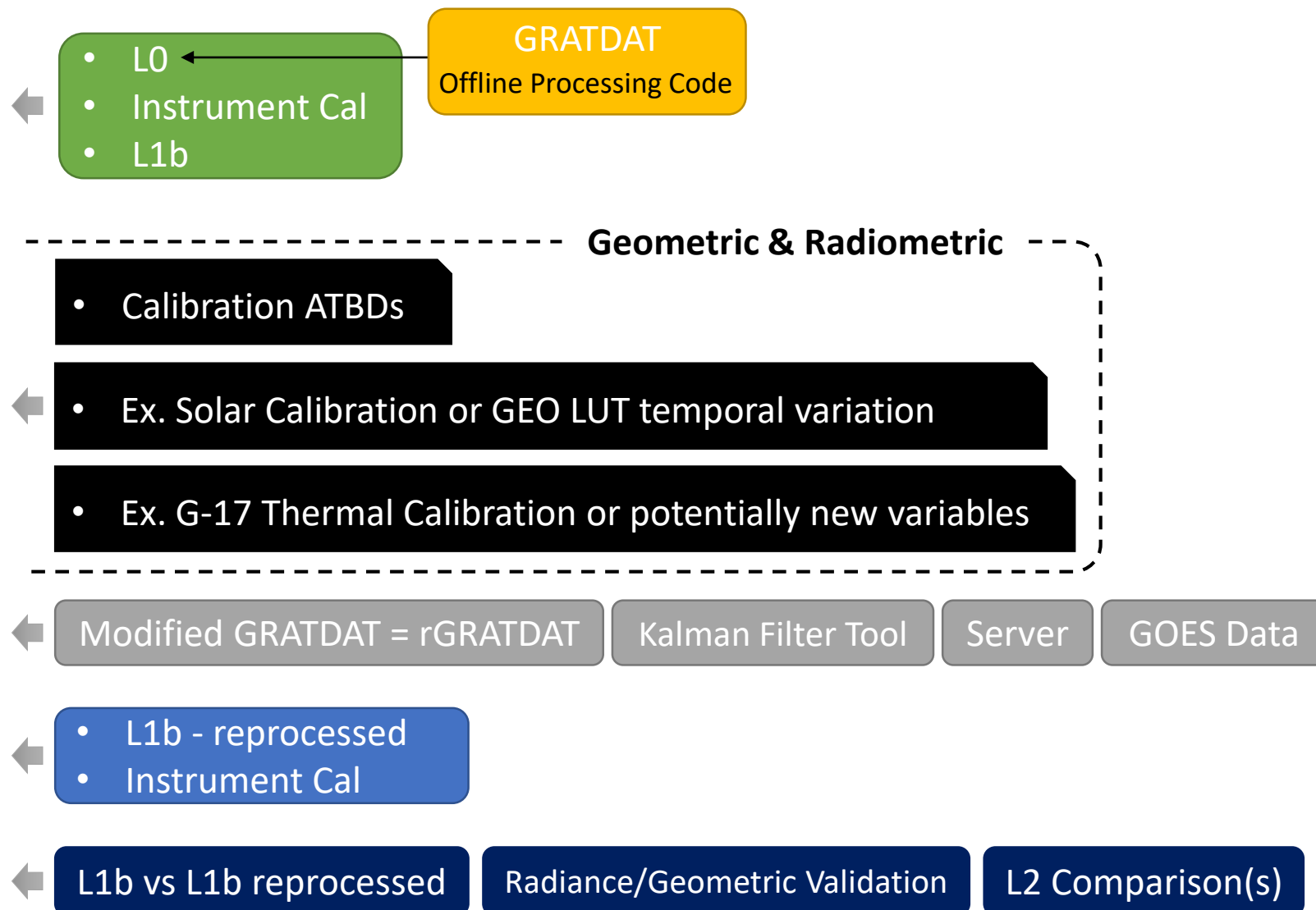
Calibration Algorithm

Data Processing

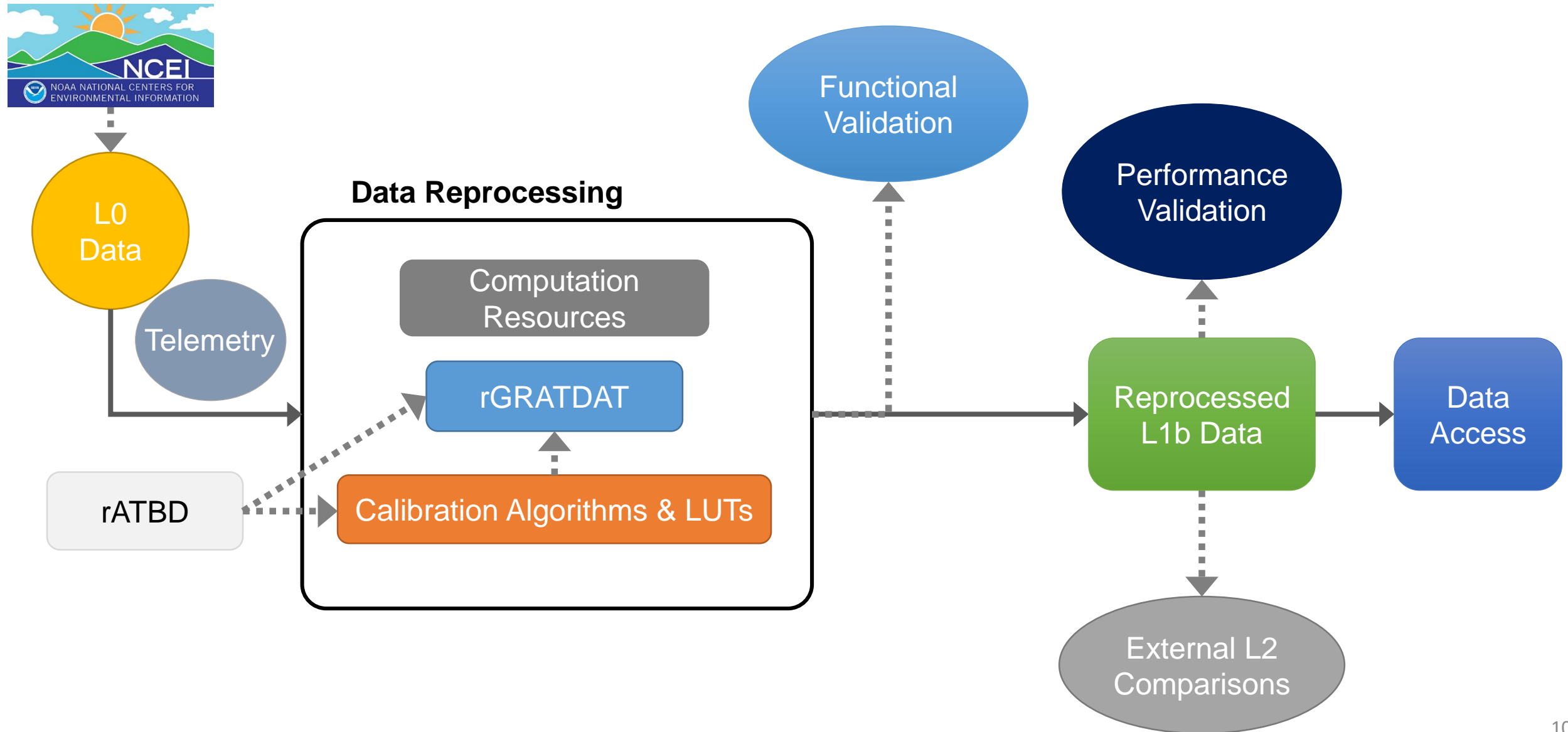
Re-Processed GOES Data

Data Analysis

Physical Breakdown Structure



GIST Data Workflow



Current Project Status

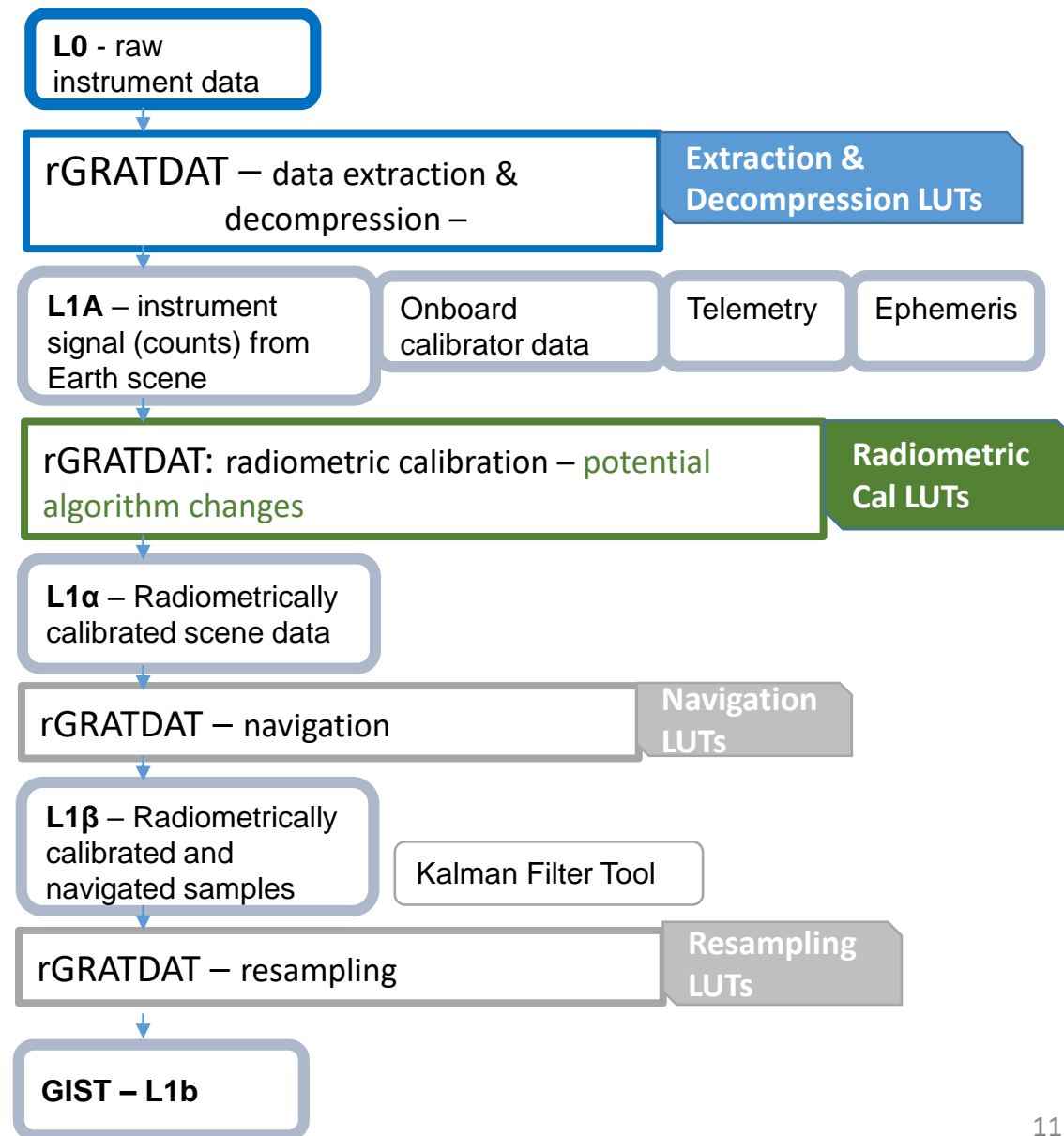
» GIST ABI L1b Re-Processing ATBDs (rATBDs) have been developed:

- Radiometric and Geometric rATBDs
- These documents establish a computational roadmap and provide documentation
 - Establishes the required ground LUTs, algorithm changes and other system parameters required to conduct the re-processing

» Refining LUT updates and beginning development of ground processing algorithm changes

Next Steps

- LUT refinements and calibration algorithm changes continue
- Functional testing is planned spring/early summer 2021
- Planned for initial L1b datasets Fall 2021
- Planning a NASA GEO science workshop fall 2021

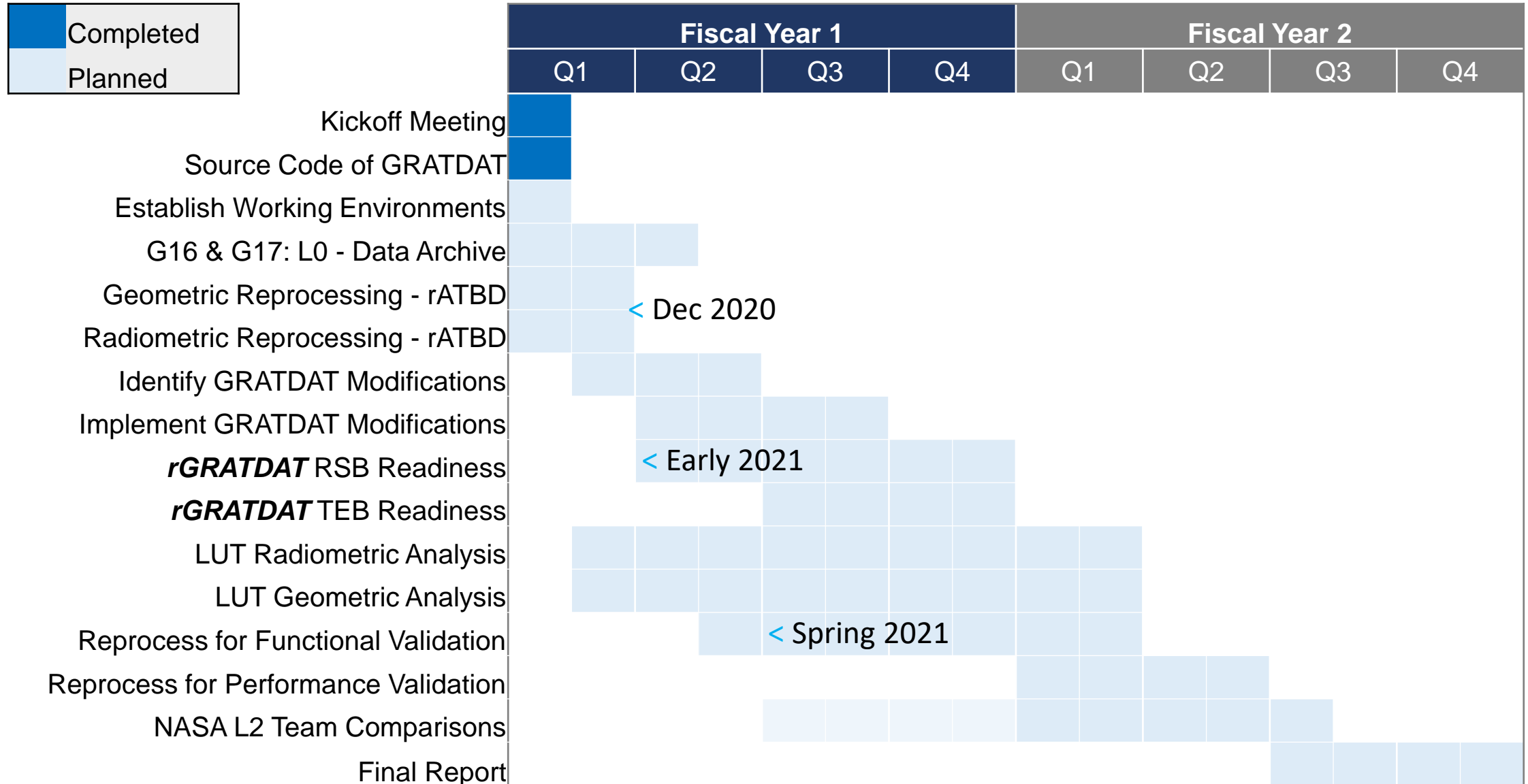


Planned Project Outcomes & Summary

- » **This effort seeks to improve radiometric and geometric calibration for GOES-16 and GOES-17 re-processing of ABI L1b data**
- » **Reprocess sub-set of one year of data:**
 - 2019 subset of ABI data (all bands) from GOES-16 & GOES-17
- » **Report the operational calibration vs reprocessed calibration over time:**
 - Trending analysis for both radiometric/geometric - gain, radiance, geometric accuracy
 - Before and after reprocessing
 - Geometric: Whole image (average of all validation sites) versus single sites
 - Radiometric: Radiance trending over validation site(s)
 - Radiance comparison over validation site(s)
 - G16 vs G17 inter-comparisons
 - NASA led: L2 comparisons using re-processed data
- » **How do I collaborate with the GIST or get access to the initial data?**
 - Initial data set is planned to be available in the late fall of 2021 – interested members request via email
- » **Potential formation of a NASA Geostationary Imaging Support Team (GIST)**

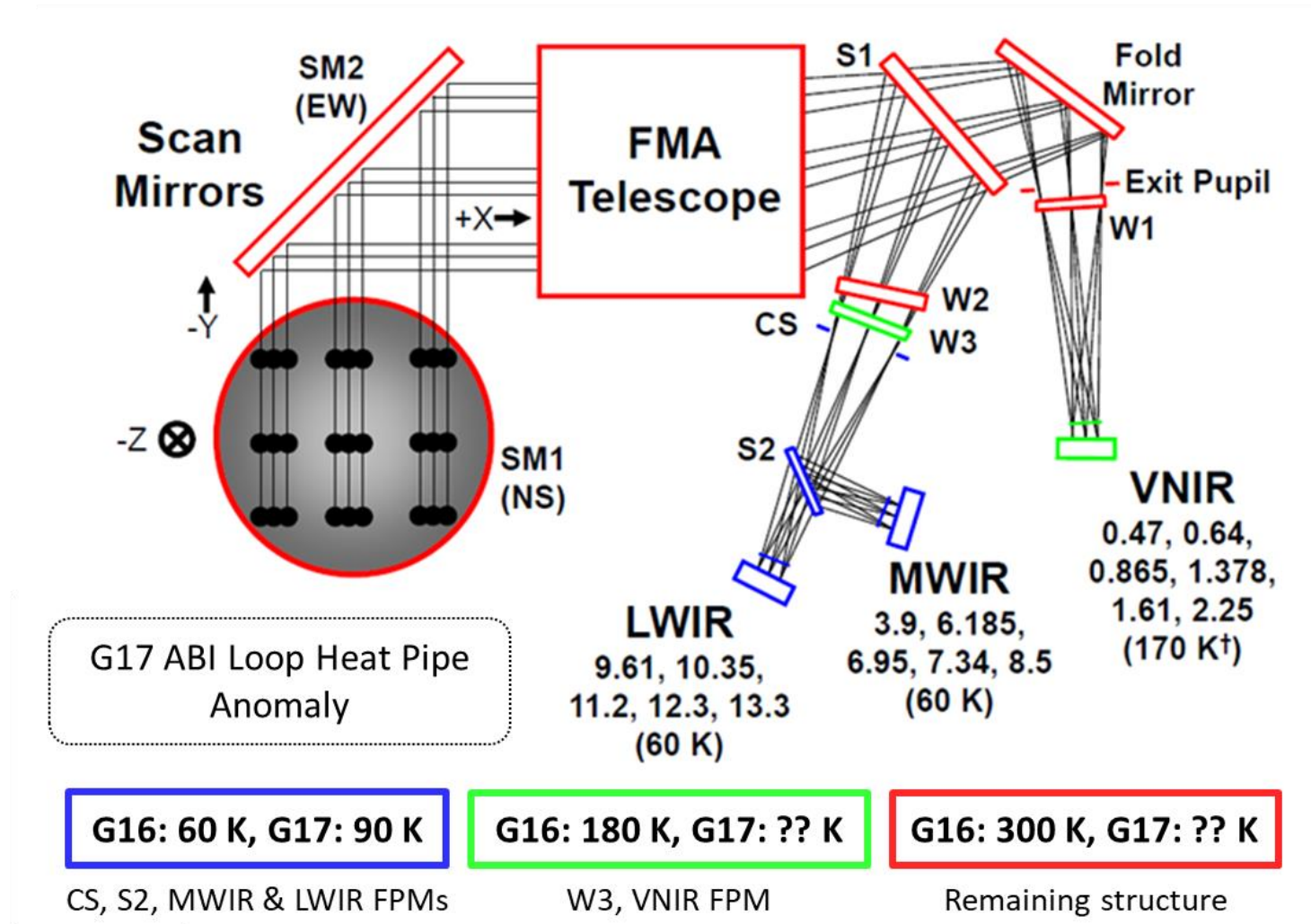
BACK-UP

Detailed Schedule



ABI Instrument Overview

Instrument Schematic



Graphics courtesy of and adapted from Harris Corp.